Carbon and Nitrogen Changes due to Soil Warming

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Background: Soil

- Soil is a complex ecosystem
  - Minerals
  - Water
  - Gasses
  - Organic Matter
    - Microorganisms

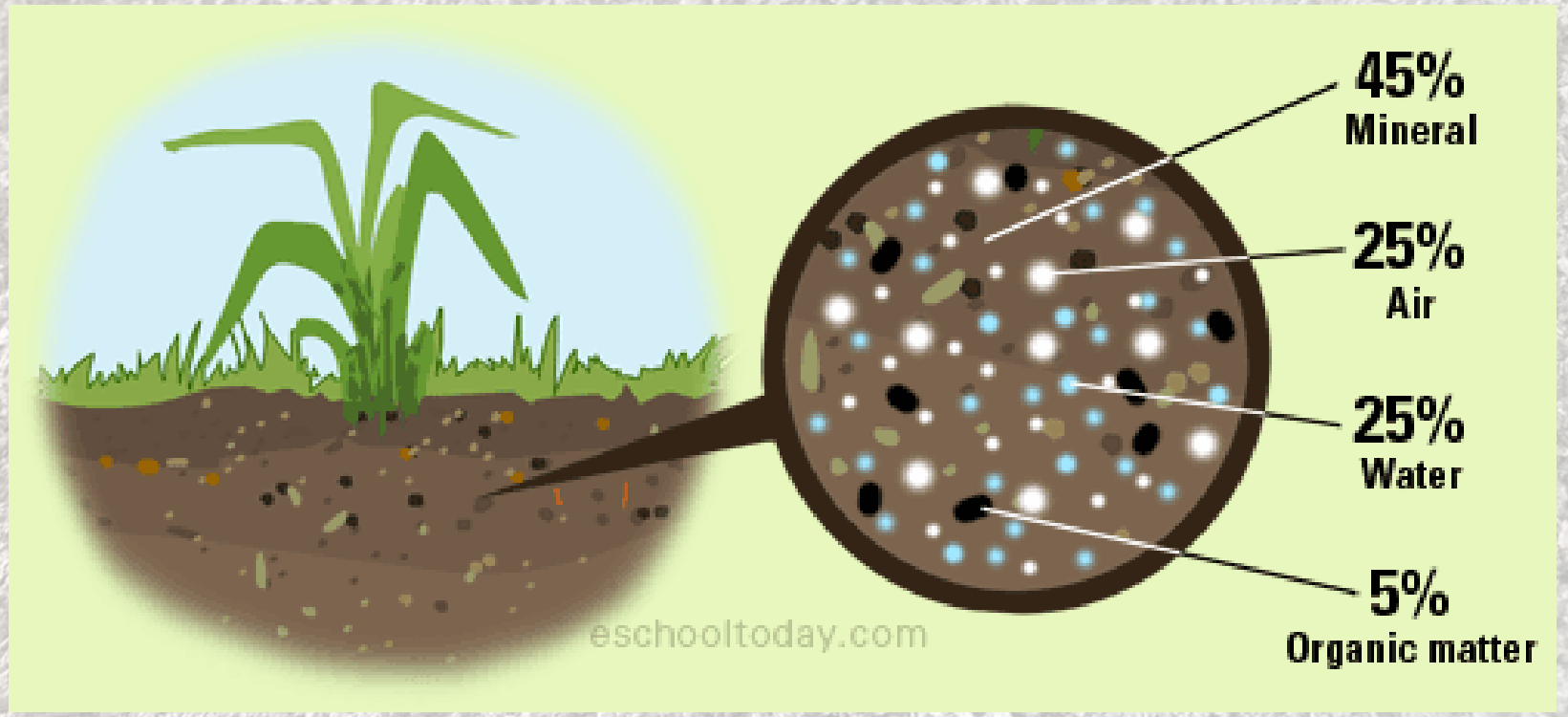
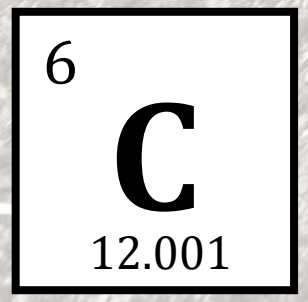


Image from eSchoolToday: Revision notes, Soil

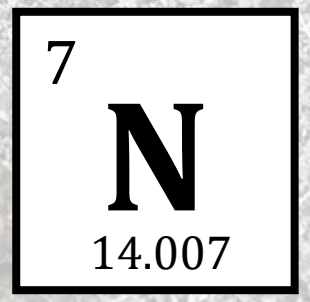
Soil Carbon

- Soil has about 1500 Pg of carbon worldwide
- As soil is heated, it releases carbon
  - Not all soil is the same
  - Plants and microbes affect carbon loss rate



Soil Nitrogen

- Soil has about 133–140 Pg of nitrogen worldwide
- As soil is heated, it can speed up mineralization (decay)
  - Could be offset by other parts of the nitrogen cycle speeding up



	Previous studies	Our study
Time	Long term 6 months-7 years	Short term 10 days
Degrees heating	Gradual, similar to greenhouse effect 1-5°C increase	Extreme, similar to heat wave 30-60°C increase
Methods	Overhead heating lamp Greenhouses Buried cables	Overhead infra-red heating lamp (sunlight-like source)
Results	Nitrogen mineralization (N loss)* Increased CO_2 flux (C loss)* Changing plant/bacteria responses	?

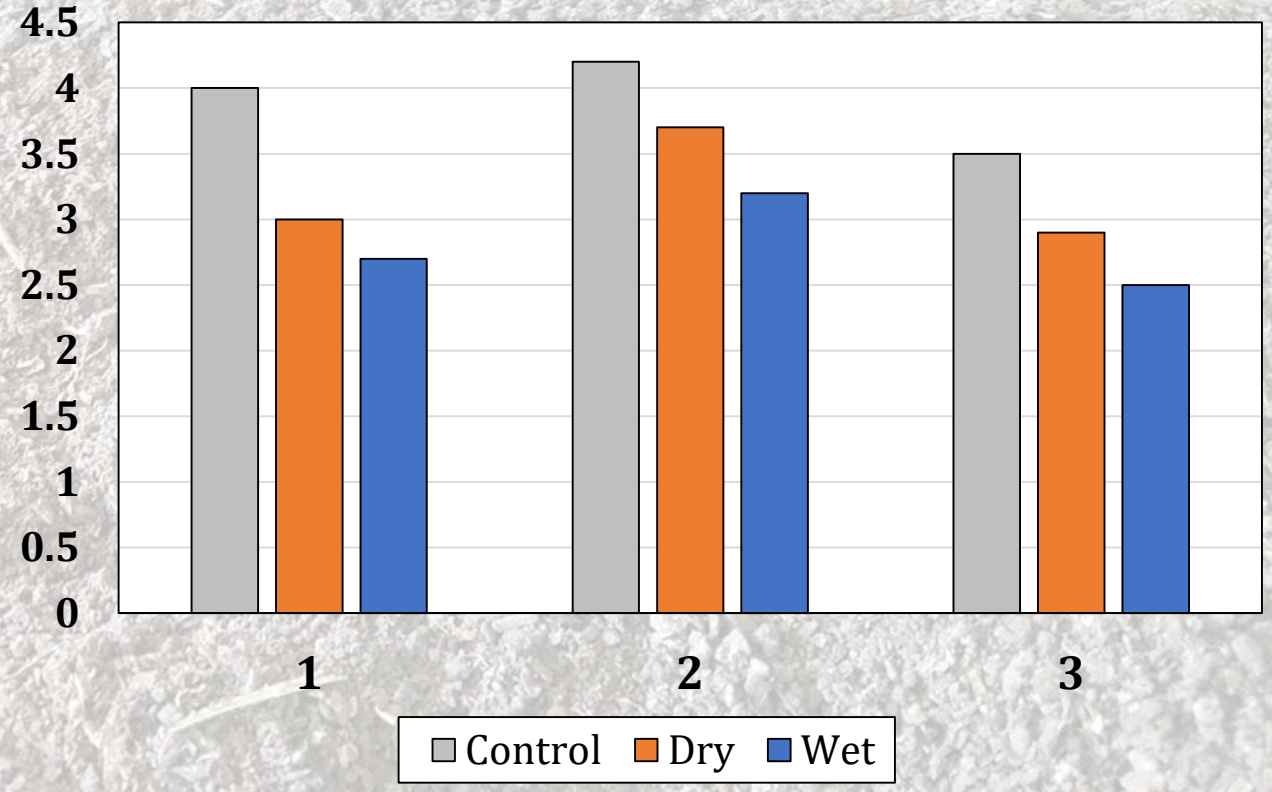
*Dependent on hydrology

Will extreme short-term heating show similar soil carbon and nitrogen losses as long-term experiments?

Hypothesis

- Carbon and nitrogen loss from soil
- More loss if watered
  - Due to microbial activity and respiration

Sample Expected Results



Site Background

- Oak Woodlands cover 10 million acres of California
  - Average carbon content: 4.1% (min 3.0% max 6.5%)
  - Average nitrogen content: 0.28% (min 0.15% max 0.45%).

- Hastings Natural History Reservation (HNHR)
  - Biological field station of Museum of Vertebrate Zoology at UC Berkeley since 1937
  - Coast Live Oak (*Quercus agrifolia*) and grassland

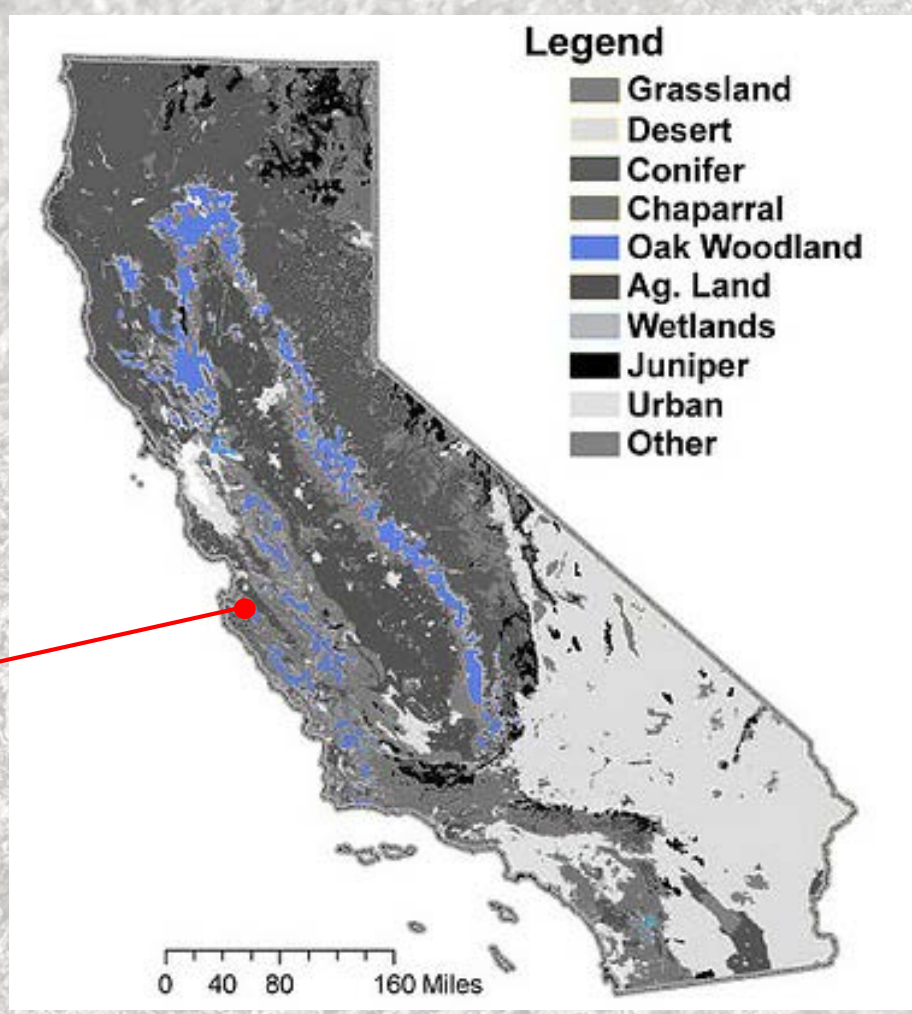


Image from "*North American Oak Woodland*" from University of Arizona, College of Agriculture and Life Sciences.

Methods: Gathering Samples

Remove plant cover

Cut ~30x3x5cm soil sample

Transfer to labeled bag

Methods: Processing Soil

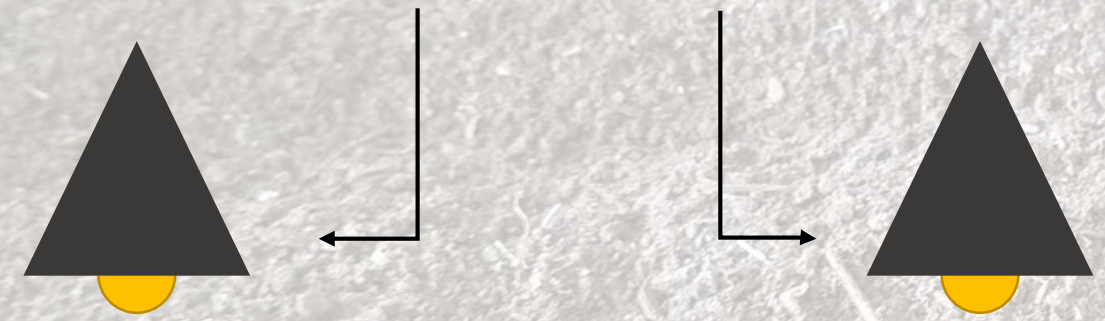
Sift through sieve

Remove large roots & seeds

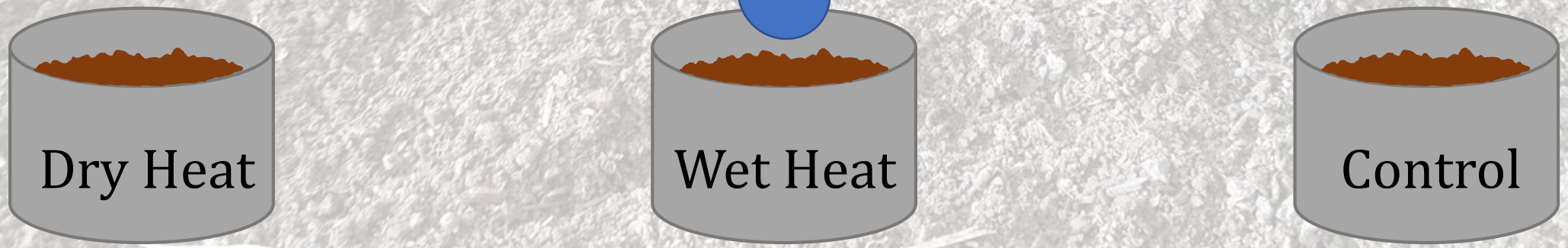
Separate into thirds
(~150g-200g each)

Methods: Heating Soil

Heat lamps, 6 hours a day, 10 days total



35mL water every 5 days



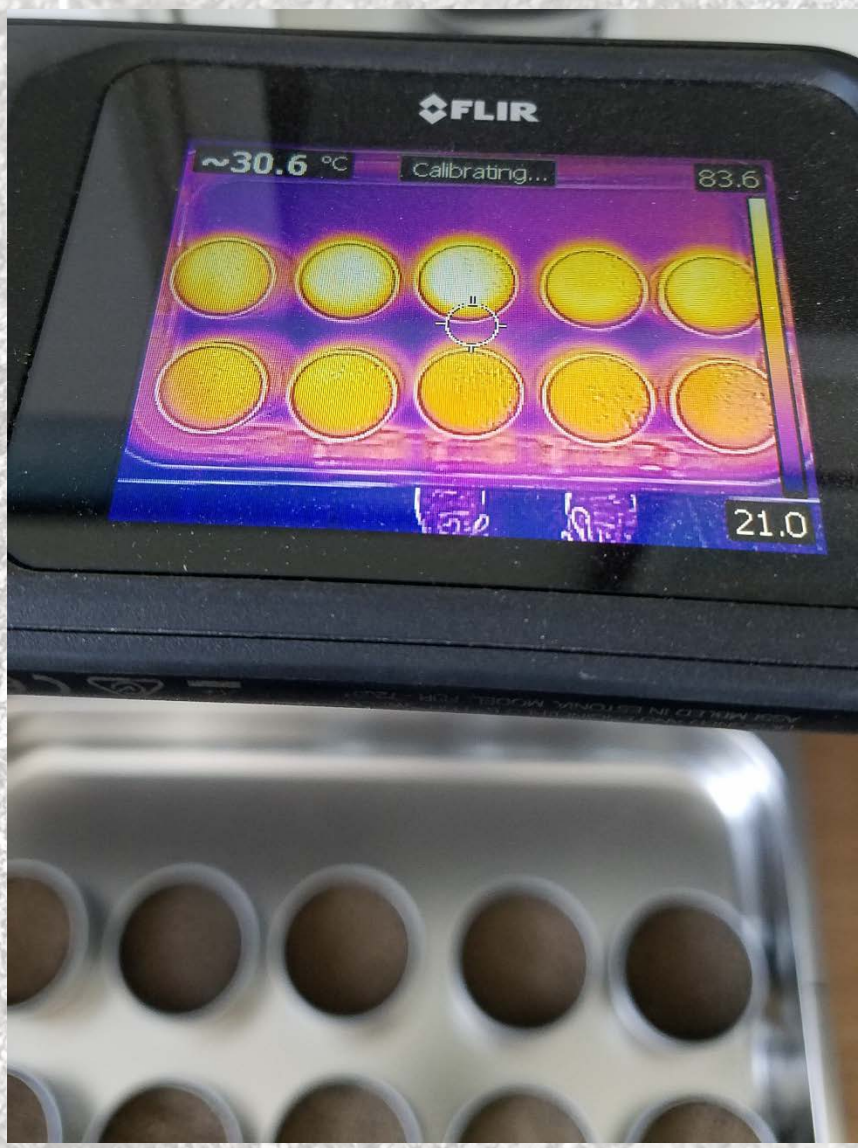
10 samples

10 samples

10 samples

Half the samples were heated at high (direct) heat; half were heated at low heat.

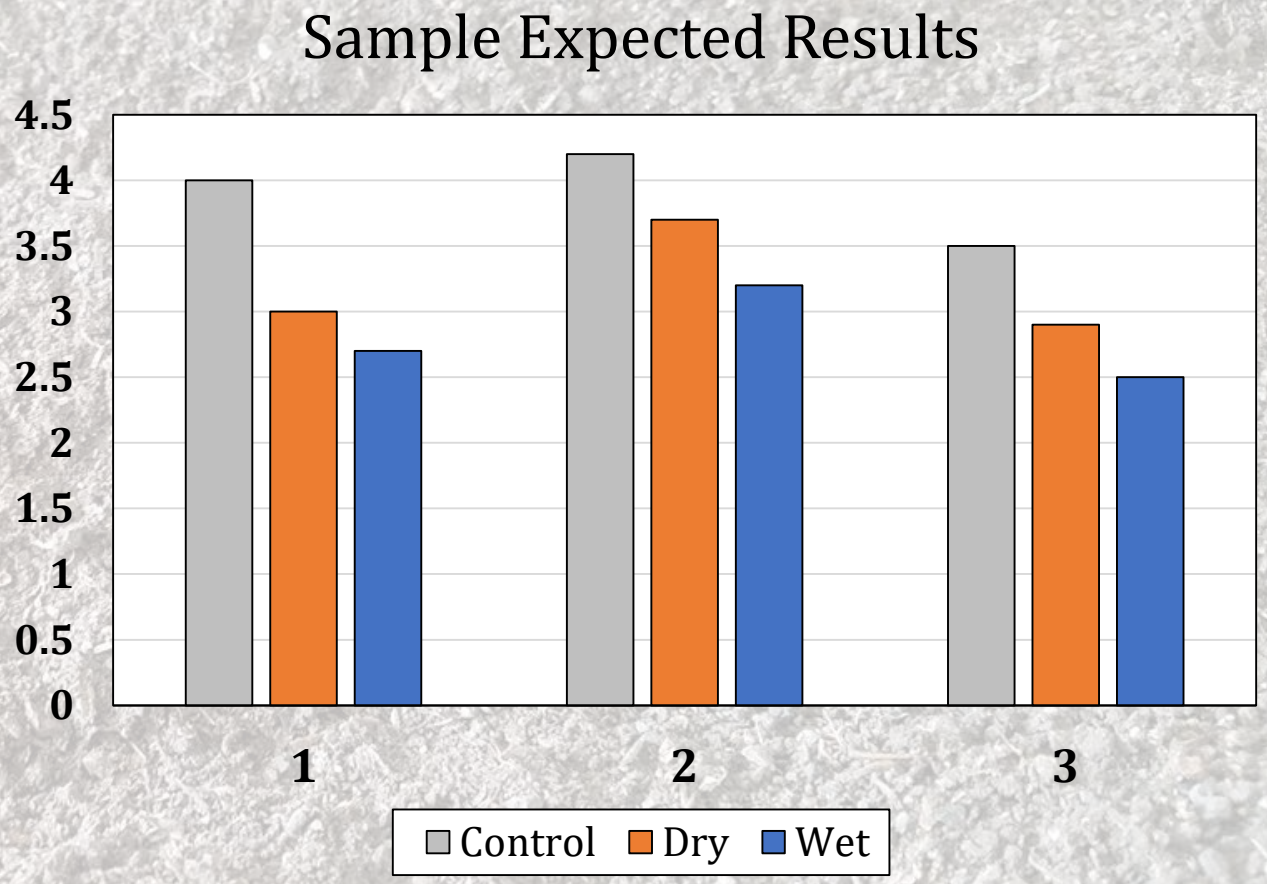
After treatment, samples were mailed to OSU's Central Analytical Laboratory (Crop and Soil Science Dept) for analysis



What I expect to find…

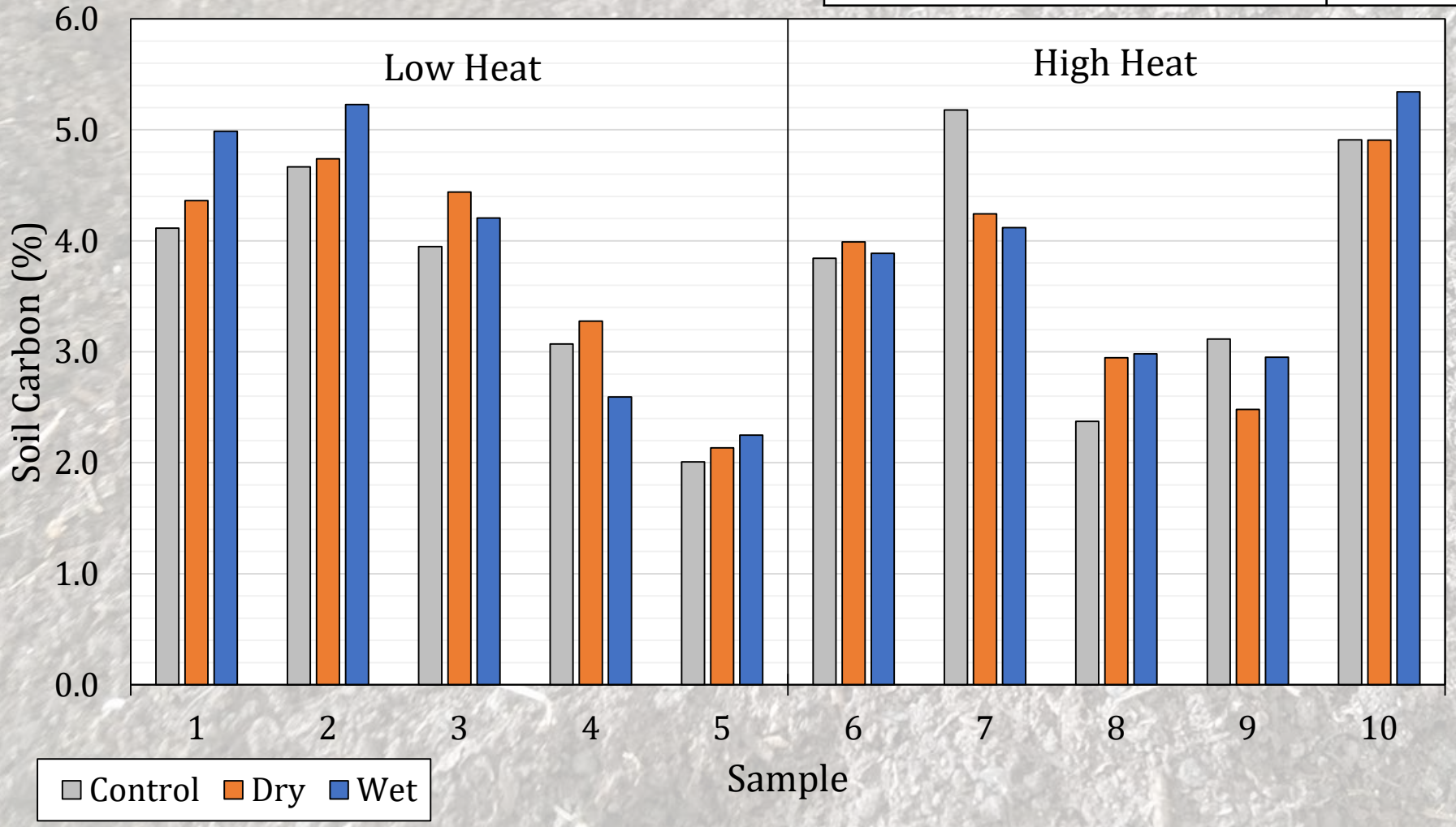
<u>Hypothesis</u>

- Carbon and nitrogen loss from soil
- More loss if watered
  - Due to microbial activity and respiration



Soil Carbon

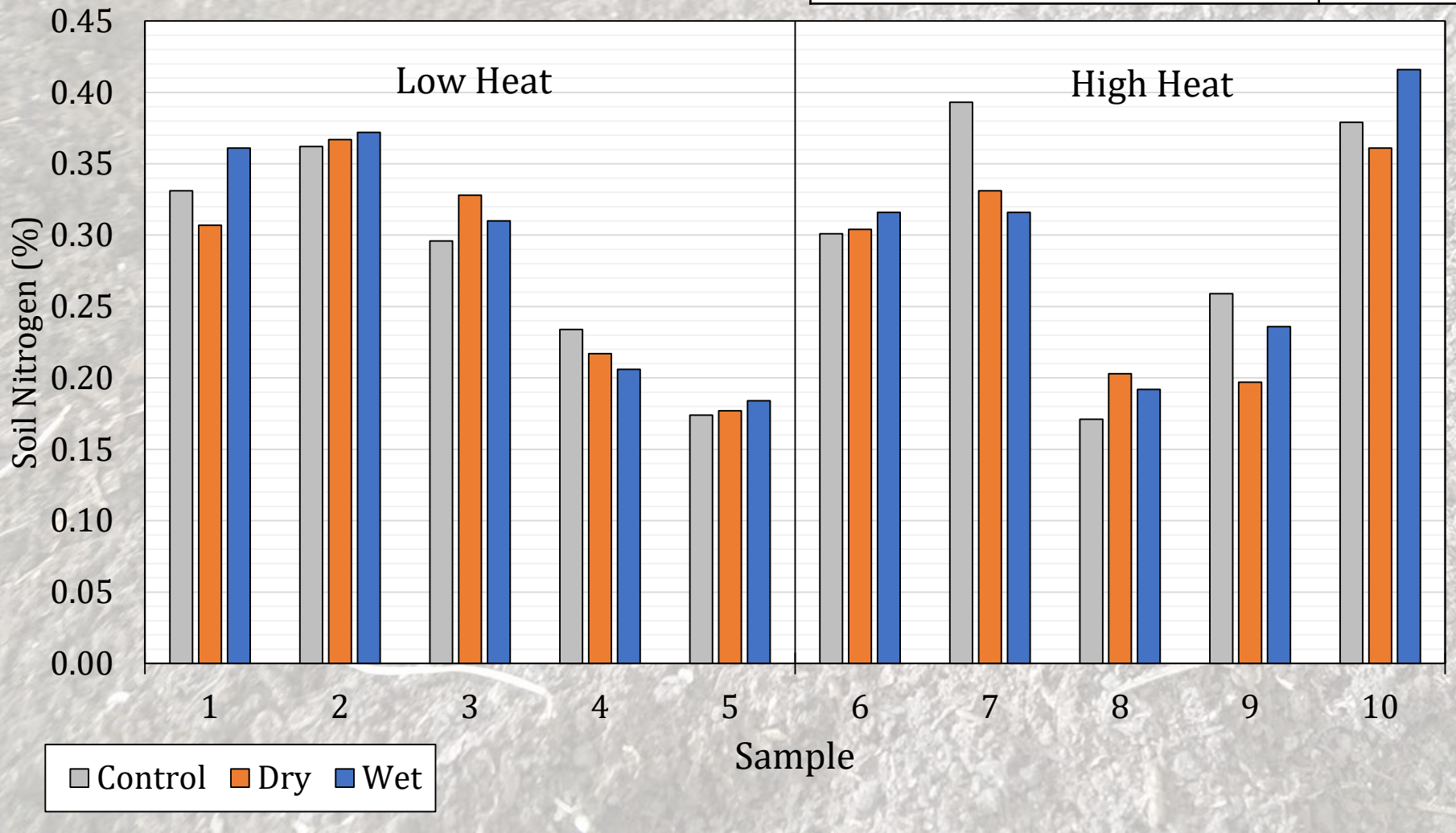
	Dry Treatment	Wet Treatment
Soil C increases	7	7
Soil C decreases	2	3
Soil C stays the same	1	0



- No clear trend
- Changes are very small
- Average Carbon = 3.78% ± 1.02

Soil Nitrogen

	Dry Treatment	Wet Treatment
Soil N increases	5	7
Soil N decreases	5	3
Soil N stays the same	0	0



- No clear trend
- Changes are very small
- Average Nitrogen = 0.29% ± 0.08

Conclusions

Extreme short-term warming seems to be ineffective in reducing carbon and nitrogen in Oak Woodlands soil.

Further Questions

Extreme short-term warming seems to be ineffective in reducing carbon and nitrogen in Oak Woodlands soil.

Should short-term warming show the same results as long term?

- Not necessarily

What if there is CO_2 being lost, but it's not enough to show?

- Previous studies: around 0.001 to 0.006 mgC cm^{-2} hr^{-1} net loss comparing control plots and heated plots
- Our study: around 19610 mgC cm^{-2} in the soil sample, 60 hours of heating
  - Result: only 0.36 mgC cm^{-2} loss

Classroom Research

- Thomas Jefferson High School IB Environmental Science students
- Long-term extreme soil heating study
- Student-run
- Ongoing through the school year

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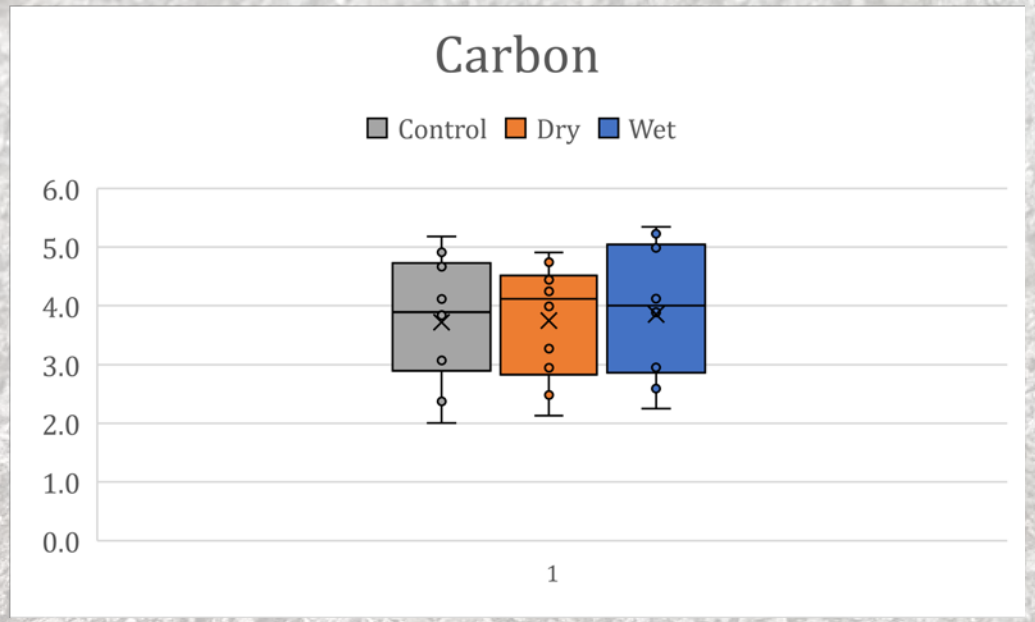
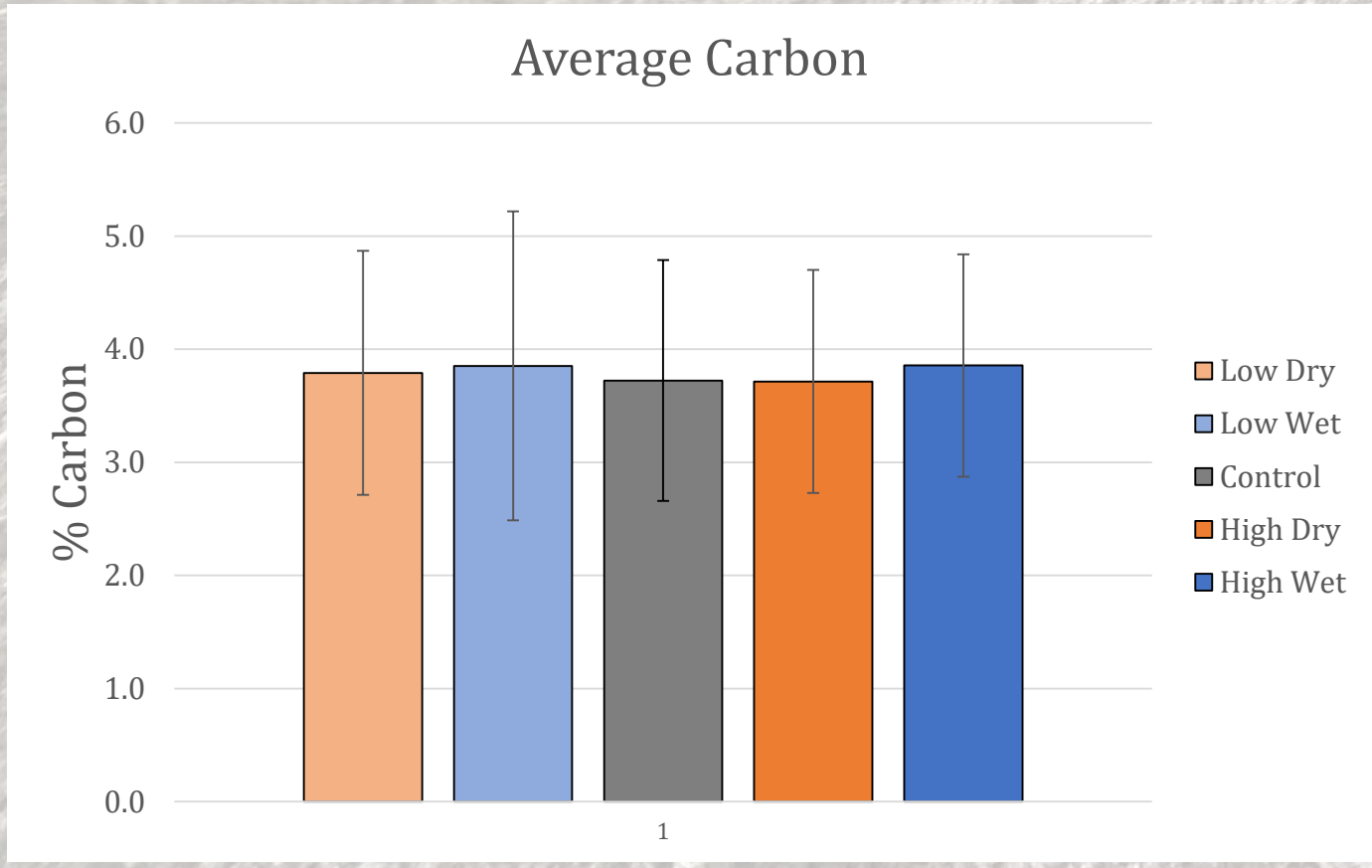
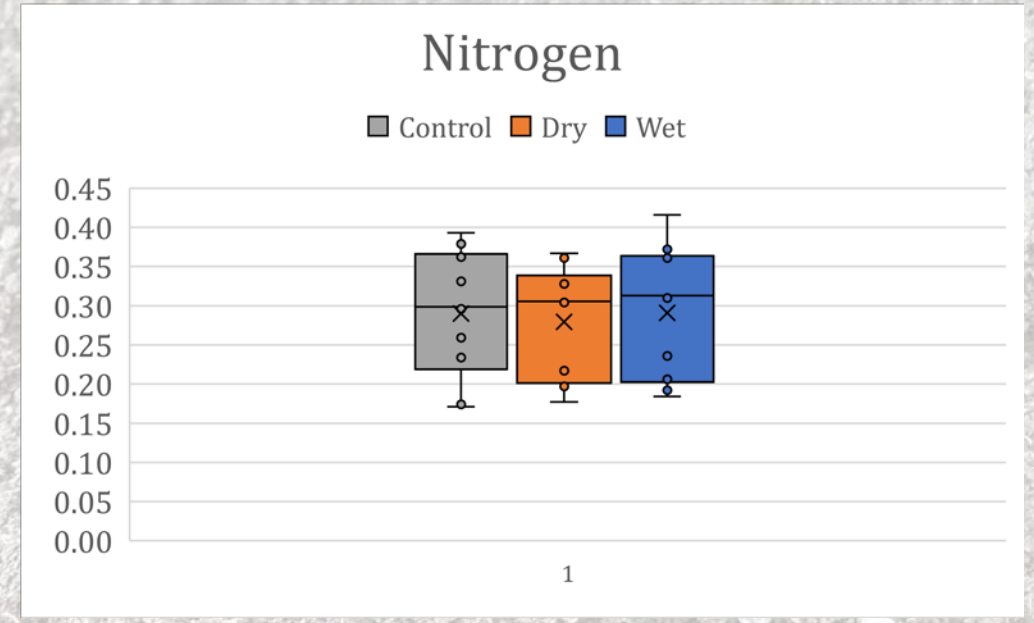
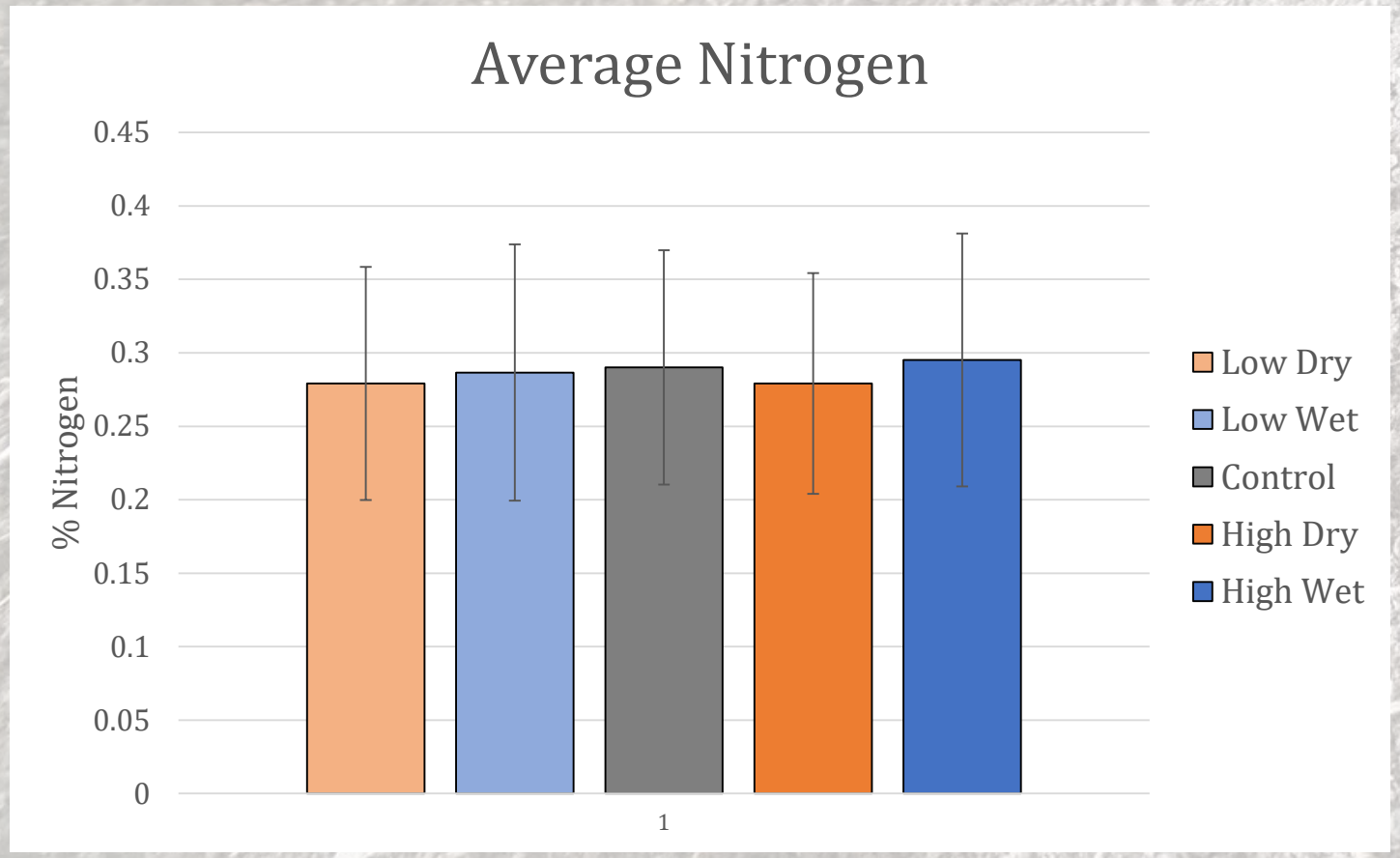




Carbon	Average	Stdev	Coef of Var
Control	3.7	1.06	28.59
Low Dry	3.8	1.08	28.47
High Dry	3.7	0.99	26.56
Low Wet	3.9	1.36	35.43
High Wet	3.9	0.98	25.48





Nitrogen	Average	Stdev	Coef of Var
Control	0.29	0.08	27.51
Low Dry	0.28	0.08	28.42
High Dry	0.28	0.08	26.89
Low Wet	0.29	0.09	30.42
High Wet	0.30	0.09	29.15